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CLINICAL COMMENTARY

CURRENT CONCEPTS IN THE TREATMENT OF PATELLAR TENDINOPATHY

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ABSTRACT

Patellar tendon pain is a significant problem in athletes who participate in jumping and running sports and can interfere with athletic participation. This clinical commentary reviews patellar tendon anatomy and histopathology, the language used to describe patellar tendon pathology, risk factors for patellar tendinopathy and common interventions used to address patellar tendon pain. Evidence is presented to guide clinicians in their decision-making regarding the treatment of athletes with patellar tendon pain.

Level of Evidence: 5

Keywords: Anterior knee pain, jumper's knee, overuse injury, patellar tendinopathy, patellar tendonitis, patellar tendinosis

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INTRODUCTION

Patellar tendinopathy is a common overuse disorder typically occurring in athletes who participate in sports that require jumping, including volleyball and basketball, hence the label "jumper's knee."[1-6] Cook et al[7] reported that 7% of 14-18 year old junior Australian basketball players had clinical signs of patellar tendinopathy and 26% of the tendons (n = 268 tendons, 134 players) showed a region of abnormal tendon tissue based on diagnostic ultrasound (US). A study of 760 adolescent athletes across 16 different sports revealed a prevalence of 5.8% of athletes with patellar tendon pain.[8] Ferretti[9] reported a 22.8% incidence of patellar tendon pain in a sample of 407 elite volleyball players, and Taunton et al found that 4.8% of 2000 runners had patellar tendon pain.[10] Lian, Engebretsen, and Bahr[11] studied the prevalence of jumper's knee in 613 elite Norwegian athletes and reported an overall prevalence of 14.2% with the highest prevalence in volleyball (44.6%) and basketball (31.9%). In a study of 891 non-elite athletes representing seven different sports, the overall prevalence of patellar tendinopathy was 8.5% with the highest prevalence in volleyball athletes (14.4%)

The management of patellar tendon pain has been somewhat complicated by the terminology used to describe the condition. The term "patellar tendonitis" has been used indiscriminately by many health care providers to describe patellar tendon pain. However, multiple histopathologic studies have indicated that the primary pathologic process in most painful tendons is degenerative rather than inflammatory.[12-16] Consequently, use of the "-itis" suffix appears to be questionable in describing the tendon pain as inflammatory in nature. Based on histopathology, several authors have suggested that the term "tendinitis" be abandoned in favor of the term "tendinosis", which describes a degenerative tendon condition.[17-19] This distinction regarding tendon pathology was first described by Puddu[20] with regard to classifying Achilles tendon pain. In an alternate perspective, Fredberg[21,22] has challenged the concept of patellar tendon pain as a degenerative condition, suggesting that a lack of inflammatory cells may not mean the lack of an inflammatory process. Other tissue research has shown the presence of pro-inflammatory chemical agents such as cyclooxygenase, growth factors, and prostaglandin in painful patellar tendons[16,23] as well as macrophages and lymphocytes in chronic tendinopathy,[24] suggesting that there may be an inflammatory component in patellar tendon pain. In their review of inflammation and tendon pain, Rees, Stride and Scott concluded, "The evidence for non-inflammatory degenerative processes alone as the cause of tendinopathy is surprisingly weak."[25, p1] However, these authors further stated that "We do not advocate going back to the 'tendinitis' model, and there is no doubt that a shift away from primarily anti-inflammatory strategies has had great benefit for tendinopathy treatments."[25,p.5] As the language used with patients can have a strong influence on how the patient and practitioner thinks about the condition,[26] it is advisable that the language of "patellar tendinitis" be abandoned in favor of *patellar tendinopathy* to move away from a pure inflammatory mindset.

HISTOLOGY OF THE PATELLAR TENDON

The patellar tendon extends distally from the infrapatellar pole to the tibial tubercle. Some anatomists argue that as the patellar tendon appears to connect the patella and tibia, it should be termed the patellar ligament.[6] However, embryologically there is a single tendon attaching the quadriceps to the tibia in which a mesenchymal condensation develops and becomes the patella, a sesamoid bone. The formation of the patella appears to separate the tendon into two regions, the quadriceps and patellar tendons although they are, in fact, a continuous, anatomic tendon entity. In an adult, the patellar tendon is 25-40 mm wide, 4-6 cm long, and 5-7 mm thick.[27,28] At the site of attachment of the patellar tendon to bone (tibia and patella), there is a fibrocartilaginous enthesis with four tissue zones - dense fibrous connective tissue, uncalcified fibrocartilage, calcified cartilage, and bone.[29] The collagen fibers in the tendon are arranged in a parallel fashion and the tendon appears white. The patellar tendon does not have a well-developed paratenon but the posterior surface of the tendon is intimate with the fat pad, a structure that is highly innervated and vascularized. Duri et al stated, "We believe that the intensity of pain in some patients with patellar tendonitis is related to the involvement of the fat pad."[30,p105]

Patellar tendon pathology typically occurs at the enthesis site; in most cases it occurs at the inferior pole of the patella, but it can occur at the tibial tubercle or at the proximal aspect of the patella in the quadriceps tendon.[9,31] Macroscopically, the diseased portion of the tendon appears yellow-brown in color and disorganized.[5] Microscopically, the pathology involves both matrix and cellular changes. Histologic examination of pathologic tendon tissue reveals loss of the longitudinal arrangement of collagen bundles, clefts between collagen bundles filled with mucoid ground substance, increased cellularity (fibroblasts), and neovascularization.[5,13-15,32-35]There is also a loss of the typical demarcation between the calcified and uncalcified fibrocartilage zones at the enthesis,[36] and there may be local foci of abnormal calcification in the tendon as well.[15,37]

RISK FACTORS

Patellar tendinopathy is an overuse injury with the onset typically characterized by no single specific traumatic injury event but gradually increasing tendon pain. The factors that are hypothesized to contribute to the development of overuse injuries are often described in two categories, intrinsic and extrinsic. Intrinsic factors are those contained within a person, including sex, race, genetics, bone structure, bone density, muscle length, muscle strength, joint range of motion, diet, and body composition. Extrinsic factors are those outside of a person, including training volume (frequency, duration, and intensity), types of conditioning activities, specific sport activity, training surface, shoes, and environmental conditions.

Ferretti[9] studied the factors associated with the development of patellar tendon pain in volleyball players. She found a direct relationship between the number of weekly training sessions and the percentage of players with patellar tendon pain, but there was no difference with respect to type of training (weight training versus plyometrics). She also found an influence of training surface; there was a greater incidence of patellar tendon pain in the athletes who trained on concrete courts as compared to wood surfaces. Examining intrinsic factors including sex, age, knee alignment, Q-angle, patellar position, femoral version, hypermobility, foot morphology, and body morphotype, the author found no consistent relationship between these factors and patellar tendon pain. Based on her findings, Dr. Ferretti concluded that extrinsic factors were more significant in the cause of patellar tendon pain as compared to intrinsic factors.[9] Visnes and Barr[38] conducted a four-year prospective cohort study with a sample of elite adolescent volleyball athletes and found the athletes who developed jumper's knee had greater total training volume and greater match exposure as compared to those athletes who were asymptomatic.

Sport specialization has been reported as a risk factor for patellar tendinopathy. Hall et al[39] completed a retrospective cohort study of 546 middle and high school athletes (basketball, soccer, and volleyball) and found a four time greater risk of developing patellar tendinopathy in single sport athletes as compared to multi-sport athletes.

Witvrouw et al[40] examined the influence of selected intrinsic factors on the development of patellar tendon pain including anthropometric variables, leg alignment, flexibility, and muscle strength. In a group of 138 college physical education students followed over a two-year period, 19 developed patellar tendon pain. Using stepwise logistic regression, these researchers found the only variables associated with the development of patellar tendon pain were decreased quadriceps and hamstring flexibility. Mann et al.[41] also found limited quadriceps flexibility to be a risk factor for patellar tendon abnormality based on US imaging. Limited hamstring flexibility as a risk factor for patellar tendinopathy was supported by Cook et al[42] in their study of elite junior basketball players. Two groups of investigators have found the intrinsic variable of leg-length inequality to be associated with patellar tendon pain.[30,43]

Intrinsic factors with regard to patellar tracking and patellar position have been described as associated with patellar tendon pain. Kujala et al.[43] reported an association between patella alta and jumper's knee. Allen et al.[44] studied the relationship between patellar tracking (evaluated with dynamic magnetic resonance imaging (MRI) and patellar tendinopathy as identified by the presence of high signal intensity in the patellar tendon. The authors reported 45% of the patients with patellar tendinopathy had abnormal tracking as compared to 29% of the patients without MRI-identified patellar tendon changes.

Several authors have considered the effect of performance characteristics on the development of patellar tendinopathy. Richards et al[45] studied knee joint dynamics during jumping in elite volleyball players. They found increased vertical ground reaction force during the take–off phase of spike and block jumps was associated with an increased risk of patellar tendon pain, as well as increased knee flexion during landing from jump and a greater external tibial torsion moment during takeoff. In a follow-up study, Richards et al[46] examined the influence of ankle joint dynamics on patellar tendinopathy in elite volleyball players. Using logistic regression to predict the presence or absence of patellar tendon pain, the authors found that the ankle inversion moment during landing from the spike jump was a significant predictor of patellar tendinopathy. Mann et al.[41] compared a stop-jump task between those with and without patellar tendon abnormality on US imaging. These authors found the athletes with patellar tendon abnormality demonstrated less hip motion and greater knee flexion with this task as compared to those athletes with normal tendons. In a systematic review of jumping mechanics and patellar tendinopathy, Van der Worp et al[47] concluded that a stiff landing pattern with limited knee motion at landing and a short landing time is associated with patellar tendinopathy. These authors suggested that patellar tendinopathy might be better represented as "lander's knee" rather than "jumper's knee" as the landing from a jump is more likely related to tendon pain than the take-off for the jump.

The relationship between patellar tendon pain and jumping ability has also been supported by Lian et al[48] and Cook et al.[42] Lian et al[48] studied jump ability and demographic variables in a group of elite volleyball players. They found that greater body weight; more frequent weight training sessions per week, and better jumping performance was associated with an increased risk of patellar tendon pain. Cook et al[42] studied the relationship between anthropometry, physical performance test and US findings in a group of elite junior basketball players. While these authors found no relationship between anthropometric variables (height, weight, and arm span) and US findings, they did report better vertical jump performance in athletes with abnormal US findings in patellar tendons.

Van der Worp et al[49] conducted a systematic review on the risk factors for patellar tendinopathy, and reported that nine factors had "some" evidence to support them as risk factors for patellar tendinopathy although none has strong evidence to support. These factors included weight, body mass index, waist-to-hip ratio, leg-length difference, arch height of the foot, quadriceps and hamstring flexibility, quadriceps strength and vertical jump performance.

INTERVENTIONS FOR PATELLAR TENDINOPATHY

The intervention plan for patellar tendon pain should be based on an evidence-based approach which incorporates the clinical judgment of the clinician, the patient's values, and the best available evidence.[50] Although patellar tendinopathy is a relatively common condition in athletes, there is very little high-level evidence to support interventional choices. Consequently, the clinician's clinical reasoning should be based on impairments identified in the examination, which are related to the patient's activity and participation limitations. Based on the current histopathologic knowledge, it appears inappropriate to focus intervention solely on an inflammatory process in the tendon; rather, the intervention should be focused on tendon healing and strengthening and return of the patient to their preferred functional activities. Knowledge of the evidence-based risk factors for patellar tendinopathy can be of assistance is considering the appropriate interventions for a specific patient.

Initially, reducing load on the painful tendon is indicated to minimize further progression of pathology. Given that substantially decreasing tendon load has a negative effect on tendon strength,[51] this load reduction can be accomplished by a decrease in the overall training volume of the activity rather than completely resting the tendon. The training volume parameters – intensity, frequency, or duration – should be evaluated and adjusted based on the athlete and the circumstances of the clinical case. To maintain cardiovascular and pulmonary fitness, cross training activities that involve lower loads on the tendon are appropriate. For athletes in jumping sports such as volleyball and basketball, this may involve the use of cycling, swimming, or pool running rather than overground running and jumping.

Decision-making regarding therapeutic exercise should be based on the presence of muscle strength or length impairments identified in the examination. Based on the work of Witvrouw et al,[40] Cook et al,[42] and Mann et al,[41] decreased hamstring and quadriceps length may be associated with patellar tendon pain. These findings suggest that if a quadriceps or hamstring muscle length impairment exists, muscle stretching exercises are indicated. Dimitrios, Pantelis, and Kalliopi[52] found that the addition of hamstring and quadriceps stretching to an eccentric exercise program was superior in outcomes (pain and function) to eccentric exercise alone for patients with patellar tendinopathy.

The mainstay in the treatment of patellar tendinopathy over the past two decades has been eccentric quadriceps exercise.[3-6,12,32,33,53-68] although the strength of evidence to support eccentric exercise for tendon pain varies across the specific tendons. The seminal work on the use of eccentric exercise in patients with patellar tendon pain was done by Curwin and Stanish.[55] They advocated the use of drop squats (Figure 1) to maximally stress the tendon to increase tendon strength. Their program involved six weeks of training, progressing in the first week from a slow speed to faster speeds, and then adding resistance in weeks two through six. During the six-week training period, the patients were to perform three sets of 10 repetitions daily; after the sixth week the training was reduced to three times weekly. In a retrospective review of 66 patients treated with the eccentric program for patellar tendon pain, the authors reported complete relief of pain in 20 patients, marked decrease in symptoms in 42 patients, and four patients reported worsening of symptoms.[69]

Jensen & DiFabio[57] evaluated the effect of open kinetic chain (OKC) isokinetic eccentric training on quadriceps strength in two groups of subjects, healthy volunteers (n = 16) and patients with patellar tendon pain (n = 15). Each group of subjects was subdivided into two groups, one group that did a home stretching program and one group that completed an isokinetic eccentric training program three times per week for eight weeks. Their results showed an improvement in isokinetic eccentric work over the training period. Karlsson et al[70] described a conservative treatment program for a group of 81 patients with patellar tendon changed as evidenced by hypoechoic lesions on US evaluation. The training program was divided into three phases, an acute phase, a rehabilitation phase, and a return to activity phase. The rehabilitation and return to

Figure 1. *Drop-squat exercise, start position on left, finish on right.*

activity phases included OKC eccentric knee extension exercise. They reported that 70% of the patients with patellar tendon pathology had excellent outcomes with their rehabilitation program. Cannell et al[61] used a randomized controlled trial design to compare the effect of drop squats and OKC concentric leg extension/leg curl exercises in patients with jumper's knee. Over a 12-week training period, both modes of strengthening resulted in decreased tendon pain and there was no difference in the numbers of athletes returning to sport activities.

High-load eccentric training has been used successfully to treat Achilles tendinopathy.[56] One feature of this eccentric training is the criticality of tendon pain during the eccentric exercise. According to the work of Alfredson et al,[12,56,59] the eccentric exercise should be painful to perform, and when a patient reaches the point that the exercise is no longer painful; the load should be increased to the point that it becomes painful again. In a pilot study of eccentric exercise, Purdham et al[71] compared standard squat and decline squat training (Figure 2) in athletes with patellar tendon pain. The exercise load was adjusted so that the exercises were always performed with some pain or discomfort.[59]

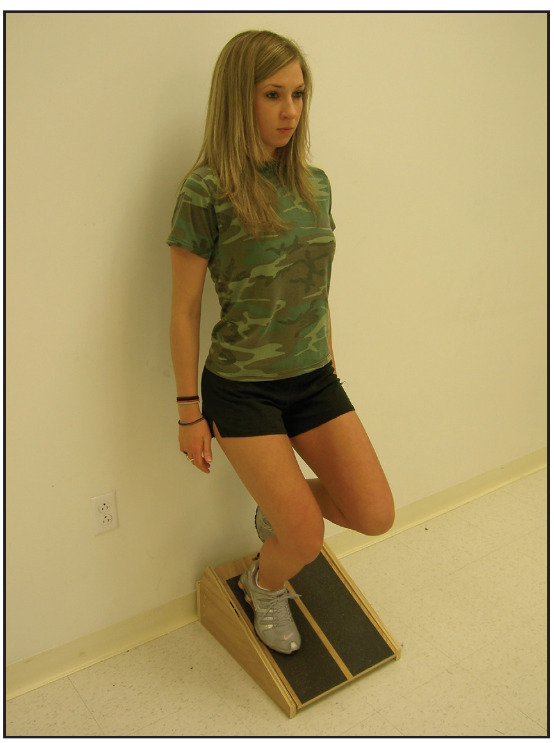

Figure 2. *Single leg decline squat.*

Six of eight athletes in the decline group returned to sport, and only one of nine athletes in the standard squat group returned to sport. The authors concluded that the decline squat was superior to the standard squat training in treating patellar tendinopathy, but acknowledged that the sample size was small and it was not a randomized design. Other investigators have also reported the effectiveness of eccentric decline squats in the treatment of patellar tendinopathy.[66,72-75]

Stimulated by the mounting evidence that supported use of the decline squat in the treatment of patellar tendon pain, several investigators have examined the biomechanics of the decline squat. Comparing tendon loading in the standard squat versus the decline squat (25° decline board), two studies have shown significantly greater patellar tendon loading and quadriceps activation in the decline squat.[76,77] Zwerver, Bredeweg, and Hof[78] examined patellar tendon loading and patellofemoral loading at different angles of decline and with/without a 10 kg backpack. Their data supported the earlier work that patellar tendon loading increases as the decline angle increases, and at angles of knee flexion higher than 60°, the patellofemoral forces rose at a higher rate than the tendon forces. The addition of the 10kg backpack caused even higher tendon loading. The authors recommended the use of a decline board between 15° and 30° decline but to keep knee flexion less than or equal to 60° to avoid excessive loading of the patellofemoral joint.

What remains unknown at this time is the optimal dosage of the decline squat eccentric training program. In the original work on high load eccentric training of the Achilles, Alfredson et al.[56] used a protocol of 3 sets of 15 repetitions twice daily for 12 weeks. Most of the research on the decline squat has used the same exercise prescription, with the additional instruction to the patient to increase the load on the tendon if the exercise becomes painfree. Generally, the recommendation is that the patient should have tendon pain greater than 0 and less than 5 on a 0-10 pain scale during the single leg decline squat. As other investigators have used a lower volume of eccentric training (3-5 days/week) with similar outcomes, [61,79] there is not a clear answer to the question of optimal dosage for eccentric exercise in patellar tendinopathy.

A second exercise approach that has been used for patellar tendinopathy is heavy slow resistance (HSR) training. In this exercise approach, exercise equipment is used for squats and leg press with heavy resistance. Kongsgaard et al[72] compared this approach to decline squats and corticosteroid injections to the tendon. They found that both exercise groups improved significantly more than the injection group, and there was no difference in the outcomes of the two groups. One must have to consider, though, that the HSR training approach requires gym equipment and substantial weight resistance whereas the decline squat training only requires a squat board and sufficient hand-held or vest weight to load the tendon to pain.

A consideration regarding intervention for athletes with patellar tendinopathy is addressing the mechanics of jumping. The combined movements of the segments in the lower extremity kinematic chain serve both as the primary propulsive force in jumping as well as the decelerative forces in landing from a jump. The research of Richards et al[45] highlights the influence of knee dynamics on the development of patellar tendon pain. Although there is presently no strong evidence to support or refute jump training for athletes with patellar tendon pain, there is evidence that ground reaction forces in jumping can be decreased with instruction.[80-83] Whether such training and improvement in the shock absorbing capacity of the lower extremity can affect patellar tendon pain needs to be subjected to further investigation. A recent case report[84] described the use of a landing strategy modification and hip extensor training for a male volleyball athlete with the athlete able to return to sport without tendon pain.

Transverse friction massage (TFM) is a technique that was advocated by James Cyriax[85] for tendon pain. This technique is purported to reduce adhesions within the tendon and encourage normal realignment of collagen fibers. There is basic science evidence from animal studies that soft tissue mobilization can increase fibroblastic activity,[86,87] but there are no studies of the effect of TFM on patellar tendinopathy tissue in humans. Pellechia, Hamel, and Behnke[88] compared a protocol of TFM and modalities with iontophoresis in the treatment of infrapatellar tendinitis. The TFM/modality group showed an increase in number of step-ups to elicit patellar tendon pain, but as this treatment group received a combined intervention, it cannot be concluded whether the effect was from the TFM, modalities, or combination. In a systematic review on the use of TFM for treatment of "tendonitis" (all anatomic types), the authors concluded that there was no evidence to support the use of deep TFM.[89] In a study that compared the effect of eccentric exercise, therapeutic US, and transverse friction massage in the treatment of patellar tendon pain,[79] the investigators found eccentric exercise to be far superior in decreasing pain at the end of treatment and after a three-month follow-up. Both the therapeutic US group and the transverse friction group had poor outcomes with 20% or less of the patients in those groups having a reduction in pain.

Although modality use is commonly employed in physical therapy clinics for patients with patellar tendinopathy, there is very little supporting evidence. Cryotherapy is commonly used in the clinic to treat pain and swelling and may be appropriate for patient use following a session of painful exercise. In a review of modality use for tendon pain, Rivenburgh[90] describes cryotherapy as having some tissue effects such as decreasing the movement of protein from capillaries and may decrease blood flow. Kaux et al[91] described a protocol for the treatment of patellar tendinopathy following platelet-rich plasma injection including cryotherapy, sub-maximal eccentrics, electrical stimulation, proprioceptive retraining, and stretching. Although the patient outcomes of the protocol were positive, the contribution of the cryotherapy after each session is unknown. Consequently, there is no direct evidence to either support or refute its use with regard to the outcome of intervention for patellar tendon pain.

Therapeutic ultrasound (US) is also a commonly utilized clinical modality for tendon pain. However, like cryotherapy, there is no direct evidence to support its use in patellar tendon pain. Therapeutic US has been shown to have positive effects on collagen production in vitro[92], but no in vivo studies were located. It has also been shown to have a significant thermal effect when using a 3 MHz treatment at 1.0 W/cm^2,[93] but whether this is desirable for healing of tendon pain is not known. In their systematic review of the treatments for patellar tendinopathy, Larsson, Käll, and Nilsson-Helanderconclude, "Ultrasound can likely be excluded as a treatment for patellar tendinopathy." [94,p. 1]

Phonophoresis is a technique in which US is used to drive a pharmaceutical agent through the skin into a painful region. Klaiman et al[95] compared the effect of US and phonophoresis using fluocinonide (a corticosteroid) on various musculoskeletal conditions including tendon pain. They found that US alone decreased pain and increased pressure tolerance, but the addition of fluocinonide did not augment the effect. Penderghest, Kimura, and Gulick[96] also examined the effect of the addition of phonophoresis to a stretching and strengthening program for patients with tendon pain. Of the 24 athletes in the study, nine had "knee tendinitis." Their results were consistent with those of Klaiman et al[95] that phonophoresis with dexamethasone/lidocaine did not appear to augment pain relief associated with exercise intervention. These studies do not support the use of phonophoresis for patients with patellar tendon pain.

Another modality that is used clinically for tendon pain is iontophoresis. This technique is similar to phonophoresis in terms of driving a pharmaceutical agent across the skin, but the motive force in iontophoresis is a direct electric current. There is evidence from an animal study that iontophoresis is effective in driving dexamethasone into patellar tendon tissue.[97] Research by Pellecchia et al[88] showed that iontophoresis with dexamethasone and lidocaine was more effectiveness than modalities/TFM for decreasing pain and increasing function in patients with patellar tendon pain. However, the use of iontophoresis as a motive force to drive dexamethasone into tendon tissue is based on an inflammatory mindset of tendinopathy, which does not focus on the return of an athlete to their sporting activity.

One common intervention used for patients with patellar tendon pain is the use of counterforce bracing or taping. In spite of the very common use of this intervention, very limited evidence exists to support its use. Miller, Hinkin, and Wisnowski[98] focused on the effect of counterforce bracing on knee pain in military trainees. While their results did not support use of counterforce bracing for "anterior knee pain" in the research subjects, no specific mention was made of patellar tendon pain. Recently, a randomized controlled trial compared the effect of a patellar strap, patellar taping, and sham taping on patellar tendon pain in a group of subjects with patellar tendinopathy.[99] The investigators found a decrease in patellar tendon pain with a single leg decline squat and during sport activity when taped or braced as compared to no tape or brace. However, there was no difference between taping, sham taping, and bracing.

Foot orthoses are also commonly suggested for patients with patellar tendon pain, but there is no direct evidence to support or refute their use. Two investigations have suggested that a hyper-pronated foot is a risk factor for patellar tendon pain,[49,100] and from these data, clinicians may infer that controlling the pronation of the foot with an orthotic will decrease the risk of developing patellar tendon pain. However, such cause and effect evidence is lacking at the present time.

As tendon pathology has been historically labeled as tendinitis, an inflammatory condition, it is not surprising that anti-inflammatory medicines are commonly prescribed for patients with tendon pain. This includes the use of oral non-steroidal anti-inflammatory medicines (NSAIDs) and injections of corticosteroids. In a systematic review of the literature on treatment of tendinitis, Almekinders and Temple[101] reported that the use of oral NSAIDs may result in some pain relief but the effect on the tendon is not known as the follow-up time in all the studies was less than one month. Similarly, the use of injected corticosteroids may also result in pain relief in tendinopathy, but there is concern regarding the effect of corticosteroid on tendon strength.[102,103] Fredberg et al[22] conducted a randomized, double-blind, placebo-controlled study of steroid injection in patients with patellar and Achilles tendinopathy. Forty-eight patients with chronic tendon pain who had not responded to conservative intervention served as subjects, 24 with Achilles tendon pain and 24 with patellar tendon pain. Using US guided percutaneous injection into the tendon, half of each group of patients received steroid and the other half received an identical looking placebo injection. Outcome measures were tendon thickness measured by US and pressure algometry. The authors found a significant reduction in pain and tendon thickness comparing the steroid and placebo groups for both Achilles and patellar tendon pain. An interesting finding in this study is that only one-third of the painful tendons showed hypoechoic regions in the US examination. In a follow-up letter to this study, Fredberg[21] argued that the results of this study suggest that the tendinitis-tendinosis question remains unresolved. He stated, "the most obvious explanation of the significant reduction in tendon thickness and pain after only one week can most likely be explained by a reduction in an inflammatory process, and not because of a change in a pure degenerative process."[21(P270)]

A new challenge to the injection of corticosteroids into the patellar tendon was revealed in a recent study on the effect of dexamethasone on patellar tendon stem cells.[104] These authors found that the dexamethasone had a "paradoxical" effect on the tendon stem cells, inducing them to differentiate into non-tenocytes including chondrocytes and adipocytes. This evidence suggests that injection of dexamethasone into a tendon may lead to the formation of non-tendon tissue within the tendon, ultimately weakening the tendon.

In cases of recalcitrant patellar tendon pain, other options for treatment include injectables (platelet-rich plasma, whole blood, aprotinin), glyceryl trinitrate patch, extracoprporeal shock wave therapy, and surgery. As these interventions are the purview of the physician, they are not presented in this commentary. Several recent reviews provide the background and evidence relative to these interventions.[67,94,105]

CONCLUSION

Patellar tendinopathy is a common overuse condition seen among athletes, particularly those who participate in jumping sports. The management of this condition has continued to challenge health care professionals as the pathology and risk factors have not been fully elucidated. Based on the current literature and collective clinical wisdom, effective conservative intervention includes relative rest, addressing biomechanical issues, eccentric exercise, stretching, and movement retraining. Other interventions including TFM and counterforce bracing are commonly employed, but have weak or little evidence to support their use. In the case of persistent tendon pain, which interferes with functional activities, injectables or surgery may be indicated. Further research is necessary to advance our understanding of the etiology of tendon pathology and our knowledge about the effectiveness of conservative and surgical interventions.

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